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Original Article

Anthropometric profile and performance indicators in female elite beach handball players

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Abstract:
This study describes the anthropometric and physical profile of the team that was the World Champion of female Beach Handball in 2016. 12 international level field players from Spain Beach Handball National Team participated in this study. The anthropometric and physical profile of the players has been evaluated, measuring: height and weight; skin folds and somatotype was determined. For the physical profile have been measured: maximal isometric hand grip force; throw velocity (throw in static support behind the line of 6 meters; throw with three steps run throw and jump with turn of 360º); speed 5 and 10 meters; countermovement jump (CMJ) and Repeated Sprint Ability on Sand (RSAS). Somatotype obtained from the sample studied, characterized by mesomorphy- endomorphy (3,33 – 3,35 – 2,65). The physical profile shown by the beach handball players champions of the world were: handgrip show very similar values to those shown by the elite Team Handball players. Throw velocity values are slightly higher to those obtained in other studies with Team Handball players. The Spanish World Champion Beach Handball players show anthropometric characteristics with low values than those shown by Beach Handball players of other nationalities, and by Team Handball players.
Key Words: physical profile, throw velocity, cmj, somatotype

Introduction

Beach handball (BH) is a sport that appeared as an adaptation of team handball to be played on sand, basically on the beach. BH is increasing in popularity thanks to the support of the International Handball Federation (IHF), and of the continental Federations and the IOC, as shown in the organization of the World Championships since 2004.

BH has specific rules, such as a double value for goals scored after turning 360 degrees in jump, flights (actions in which the player makes the throw without contact on the ground after a pass from a teammate) or the goalkeeper; and defensive contacts are not allowed. Four players, one of whom is the goalkeeper, play on a sandy rectangular field measuring 27x12 metres for two 10-minute sets, plus a tiebreak, called a shoot-out, in the event of a tie. Therefore, BH is a heterogeneous high-intensity sport with a variety of physiological demands involving short periods of maximal power and strength, with short sprints, jumps and throws throughout a match (Pueo, Jimenez-Olmedo, Penichet-Tomas, Ortega Becerra, & Espina Agullo, 2017).

Despite the growth experienced in BH at an organizational and participation level in recent years, research describing the characteristic profile of female players of BH is limited, although there have been many studies of female team handball players (Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006; Granados, Izquierdo, Ibañez, Bonnabau, & Gorostiaga, 2007; Hasan, Reilly, Cable, & Ramadan, 2007; Lidor & Ziv, 2011; Manchado, Tortosa-Martínez, Vila, Ferragut, & Platen, 2013; Michalsik, Aagaard, & Madsen, 2015; Moss, McWhannell, Michalsik, & Twist, 2015; Vila et al., 2012; Ziv & Lidor, 2009). The results obtained in these studies have provided the reference values used to establish criteria for identifying and selecting players in female BH.

For this reason, obtaining accurate data about the anthropometric, physiological and physical profiles of world-class female BH players is necessary to increase the knowledge relating to this sport and to identify the most important qualities for successful performance. It is of great interest to establish which variables are of most importance in developing optimal training programs.

To the knowledge of the authors, only two studies provide information about the characteristics of female BH players, focusing on the physiological and nutritional profiles of female Brazilian players (Silva et al., 2016) and analysing the physical demands on female players during competition at international level (Pueo et al., 2017). Therefore, the measurement of anthropometric profiles, somatotypes and physical characteristics will provide information on the current status of female BH players and allow coaches to evaluate these players for selection and for the development of training programs (Sporis, Vuleta, Vuleta, & Milanović, 2010). Consequently, the aims of the present study were to investigate the anthropometric and physical profiles of the world-class female BH players who became the World Champions in female BH in 2016.

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Material & Methods

Participants

A total of 12 international level female field players of BH (age 22.91 ± 4.05 years; mass 61.04 ± 3.98 kg and height 167.87± 4.42 cm) participated in this study. All belonged to the National Female Beach Handball Team of the Spanish Royal Federation of Handball (Champion Team in the World Championships held in Hungary in 2016). The present investigation was approved by the Research Ethics Committee of Pablo de Olavide University and complied with the Declaration of Helsinki. All the participants signed an informed consent agreement after being informed of the aims of the study and the procedures that were to be carried out. The following criteria for participation in the study were established: a) agreeing to participate voluntarily in the experiment; and b) not having suffered any injury in the last year or any other that could influence the results or present a potential risk.

Experimental Design

This study comprised anthropometric measurements and physical performance tests on Spanish female BH players during the first training camp to prepare for the Beach Handball World Championship, held in Hungary. All measurements were carried out in the first week of June, during the third day of the training camp after 12 hours of rest since the last training session, conducted in the evening of the previous day. The subjects were asked to maintain their usual food and liquid intake during breakfast, which was consumed by each group 90 minutes before the beginning of the anthropometric assessment. In order to perform measurements, subjects were divided into three groups of 4 subjects to optimize resources and facilitate the process of measurement. The same order was maintained in the evaluation tests for the three groups, with each group consecutively beginning with the anthropometric assessment, then undertaking the physical test.

Measures

Anthropometric Evaluation. The anthropometric assessment followed the guidelines set by the International Society for the Advancement of Kinanthropometry (ISAK) (Stewart & Marfell-Jones, 2011). The measurements were carried out by a level 2 anthropometrist authorised by ISAK, taking into account the technical errors of intra-observer measurement recommended by ISAK (5% for folds, and 1% for girths and diameters). The following measurements were obtained: a) height, arm span and weight measurements were made on set scales (Seca, Barcelona, Spain) with a precision of 0.01 kg and 0.001 m, respectively; b) skin folds (sub-scapular, tricipital, bicipital, iliac crest, supra-spinal, abdominal, anterior thigh and middle leg) were obtained with a Holtain Skinfold Caliper with 10-g·mm^{-2} constant pressure. Using the formulae described, body composition was calculated using models for four components: fat mass through the equations of Withers, Craig, Bourdon, & Norton (1987); muscle mass through the proposal of Lee et al. (2000); mean somatotype following the method of Heath & Carter (1967); and classification according to the somatotype categories of Carter & Heath (1990).

Maximal Isometric Hand Grip Force Test. Maximal Isometric hand grip force was evaluated by using a handheld hand-grip dynamometer (TKK-5401), with a scale of 0.1 kg. N. (CV 6.36%). The subjects undertook familiarization with the device, which also served as a warm-up, consisting of 3 repetitions with the dynamometer. The players then performed 2 repetitions at maximum intensity with the dominant hand (Vila et al., 2012). The test was carried out in a standing position with the dynamometer set parallel to their body. In this position, the player was asked to exert maximal grip force without arm or wrist movement. The best trial was used for further analysis. For motivational purposes, the players were immediately informed of their performance. Three minutes of rest elapsed between trials to minimize the effects of fatigue.

Throw speed test. Throw velocity was evaluated with a Radar Gun Stalker Sports (Applied Concepts, Inc, Texas, USA), located 2 m behind the goal at a height of 1.25 m. Measurement was carried out in the facilities adapted for the practice of BH where the training camp was held, using three different protocols, all of them without a goalkeeper.

Before the evaluation of throwing velocity, subjects performed a 15-minute warm-up oriented to throwing, consisting of movements, passes and throws. In every situation, each player performed three throws with a regulation BH ball, as fast as possible, directly at the goal using her personal throwing technique. The best result was used for the subsequent analysis. For throws to be considered valid, the ball had to enter directly into the goal without touching the ground. In order to avoid fatigue, throws were made with 3-min rests between attempts. The players were immediately informed of the result of their throw in order to maintain motivation.

The sequence of throws was as follows: throw in static support behind the 6-m line, (CV 6.68%); throw in support three steps behind the 6-m line (CV 6.63%) and throw in jump with a turn of 360º (a characteristic action in BH because of its double value) with three previous steps, in which the last support had to be done behind the 6-m line (CV 5.87%).

Speed in 5 and 10 m races The subjects ran two 10 m races in the facilites set up for the practice of BH at the location where the training camp was carried out, separated by 3 minutes' rest. The starting position was standardized, with the lead-off foot behind the starting line, which was placed 1 m behind the first time gate. The photocell gates were placed at the start, and at 5 and 10 m. The subjects attempted to run the 10 m in the fastest possible time. The best times from the two attempts in the following splits were recorded: 0-5 m (T_5), and 10 m

(T_{10}) (CV 3.03%). A standardized warm-up protocol was performed, which incorporated several sets of progressively faster 10 m running accelerations. Sprint times were measured using photocells (Polifemo Radio Light, Microgate, Bolzano, Italy). Countermovement jump (CMJ). The CMJ is a vertical jump made by a quick flexion-extension of the legs with the minimum possible delay between the eccentric and concentric phases, which aims to reach the highest possible elevation of the center of gravity. For its execution, the subject was placed standing, with hands resting on the hips (to prevent help from the action of the arms). She bent her legs until she reached approximately a 90º angle, then proceeded to extend her legs and jump off the ground. The displacement of the center of gravity during the flight was estimated from the jump height (h), which was calculated using the recorded flight time as follows (31) $h = (g \cdot ft^2) \cdot 8^{-1}$ where "g" is the acceleration due to gravity (9.81 $m \cdot s^{-2}$) and "ft" is flight time.

CMJs were performed after the sprint test, for which subjects completed two series of five CMJs progressing in intensity, with a 2-minute recovery period between series. The measurement took place in a space prepared for the practice of sports, which had hard ground, contiguous with the area where the sprint test was performed, and measurement was conducted with an infrared platform (Optojump, Microgate, Bolzano, Italy). Each subject performed three jumps, with a recovery time between jumps of 1 minute, and was informed of the height reached after each jump. The best height obtained was used for further analysis (CV 2.47%).

Repeated Sprint Ability on Sand (RSAS). Evaluation of RSAS was undertaken in the same place as the sprint test, after the CMJ test. Because the maximum distance that a BH player can travel in a straight line is 15 m (the space between two areas), for the RSAS test, (Buchheit et al., 2009) the protocol was modified from that for for team handball players, evaluating the ability for BH players to complete sprints on dry sand. This test involved six sprints of 15 m. (7.5 + 7.5 m.), starting every 10 seconds and using using wireless photocells (Polyphemus Microgate, Racetime2Kit Light Radio, Bolzano, Italy). The performance of a global warm-up was not necessary because the subjects had been sufficiently active in the previous test and the rest time between the CMJ and RSAS tests was only 20 minutes. However, just before starting, two sprints were performed at 70% effort so the players got used to the mechanics of the task.

To obtain measurements in the RSAS test, two photocells and their corresponding reflectors were placed 4 m apart, at 7.5 m from the starting line, at a height of 1.40 m above the ground. The subjects had to stand 1 m behind the starting line, where the first photocells were placed. Timing took place between 0 and 7.5 m and between 7.5 m. and 15 m. (return). Three seconds before starting each sprint, subjects were asked to assume the ready position and await the start signal. Strong verbal encouragement was provided to each subject during all sprints. Following Spencer, Fitzsimons, Dawson, Bishop, and Goodman (2006), three scores were calculated for the RSAS test: the best sprint time (RSAS best; s), usually the first sprint; the mean sprint time (RSAS mean; s); and the percent sprint decrement (RSAS dec; %) calculated as follows: 100 - (total time/ideal time x 100), where the ideal time = 6 x RSAS best.

Statistical Analyses This study used descriptive statistics, based on the mean (m) and standard deviation (SD) (all data were checked to verify normal distribution and homogeneity using Kolgomorov-Smirnov tests and the Levene test). The reliability of the measurements of the Hand-grip tests, Stand Throw Velocity, 3 Step Throw Velocity, 360º Jump Throw Velocity, CMJ, 5 metres (s) and 10 metres (s) was evaluated using the Coefficient of Variation (CV). Analysis of the data obtained was performed using the statistical program SPSS 24.0 (IBM Statistics, Illinois, USA).

Results

Table 1 shows mean and Standard Deviation values for the anthropometric characteristics and body compositions of female BH players. In order to complete the anthropometric profiles of the players, Figure 1 shows the values obtained for girth measurements, and Figure 2 shows the total somatotype obtained from the sample studied, characterized in terms of mesomorphy-endomorphy (3.33–3.35–2.65). The physical profile shown by the BH players, who became world champions, is reported in Table 2.

Table 1. Anthropometric characteristics and body composition of female beach handball players.

		Mean ± SD	Range
Antropometric characteristics	Age	22.91 ± 4.05	17 - 32
	Weight (kg)	61.04 ± 3.98	55.80 – 67.30
	Height (cm)	167.87 ± 4.42	160 – 175.50
	Arm span (cm)	169.55 ± 4.08	164.40 – 176.40
Body composition	BMI ($kg \cdot m^{-2}$)	21.68 ± 1.45	19.80 – 24.40
	∑6 Skindfolds	84.50 ± 20.85	49.30 – 107.87
	∑9 Skindfolds	107.87 ± 26.99	62.90 – 160.40
	Muscular Mass (kg)	22.44 ± 1.30	20.61 – 24.00
	% Muscular Mass	36.79 ± 1.06	34.97 – 38.50
	Fat Mass	8.87± 2.12	5.65 – 12.97
	% Fat Mass	14.48 ± 3.06	10.12 – 19.77

SD = Standard Deviation
BMI = Body Mass Index

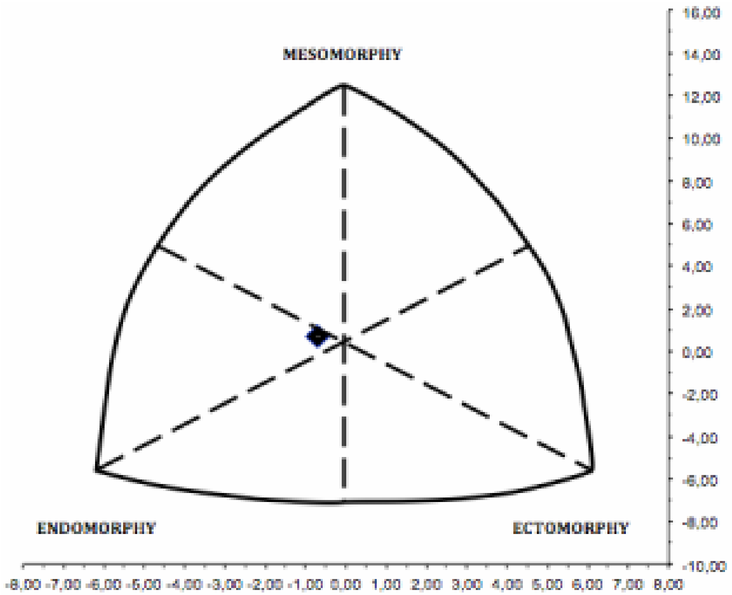

Figure 1. Representation of the somatotype in female Spanish beach handball players

Table 2. Results of physical tests performed on female beach handball players.

	Mean ± SD	Range
Hand-Grip (N)	34.35 ± 4.08	27.50 – 41.50
CMJ	34.92 ± 5.38	19.40 – 21.20
5 metres (s)	1.17 ± 0.06	1.06 – 1.25
10 metres (s)	2.04 ± 0.08	1.88 – 2.21
Stand Throw Velocity ($m \cdot s^{-1}$)	23.46 ± 4.26	15.90 – 31.10
3 Steep Throw Velocity ($m \cdot s^{-1}$)	23.65 ± 3.69	18.50 – 29.20
360º Jump Throw Velocity ($m \cdot s^{-1}$)	18.69 ± 4.26	14.20 – 28.90
RSA_{best} (s)	5.88 ± 0.27	5.27 – 5.61
RSA_{media} (s)	5.97± 0.33	5.38 – 6.56
RSA_{dec} (%)	2.47 ± 7.49	10.86 – 14.23

SD = Standard Deviation
CMJ = Countermovement Jump
RSA = Repeated Sprint Abillity

Discussion

BH is a relatively new sport, which means that so far it has received little intensive investigation, so available data is scarce. The main objective of this study was to determine the anthropometric and physical profiles of the most recent world champion female BH team, to determine whether female BH players show anthropometric and physical differences to female TH players.

To our knowledge, only one study has been published on the physiological and nutritional profile of the Brazilian BH players (Silva et al., 2016). The mean data for height are similar to those found in this study (168.0 ± 10.0 cm; 167.87 ± 4.42 cm, respectively). However, the mean weight differs, being 63.80 ± 7.1 kg for the Brazilian players and 61.04 ± 3.98 kg for the Spanish players. When we compared these data with similar studies focusing on Spanish female TH elite players, we observed that the mean data found in the Spanish BH players was lower than the means obtained by Vila et al. (2012), (171.31 ± 7.42 cm; 67.55 ± 8.06 kg). However, we note that the mean data for weight in this study coincided with those shown for the wing players (61.23 ± 4.29 kg) (Vila et al., 2012). With regard to height and size (Table 2), data show that BH players are shorter and of a larger size than TH central players, but are somewhat taller and have a larger size than wing players, according to Vila et al. (2012). These data suggest that BH players would perform better if they had a greater height and size than the wing players in TH, without compromising weight gain. If we take as a reference the weight and height of the Danish players at elite and national level, the mean data presented in this study are lower than those of the Danish players (Michalsik et al., 2015).

With regard to body mass index (BMI), no studies examining this variable in BH were found, so we note that the World Champion BH players showed a lower BMI (21.68 ± 1.45 $kg \cdot m^{-2}$) than those obtained in other studies carried out with TH players of different nationalities and levels (Bayios et al., 2006; Mala et al., 2015; Milanese, Piscitelli, Lampis, & Zancanaro, 2011; Vila et al., 2012) but higher than those found in a study with elite Spanish players (20.5 5 kg·m^{-2}) (Granados et al., 2007). The mean percentage of fat mass obtained in the current study study was 14.48 ± 3.06, much lower than that found by Silva et al. (2016) in BH players (24.90 ± 3.00) and also far below the results obtained in female TH players of different levels and nationalities (Bayios et al., 2006; Milanese et al., 2011; van den Tillaar & Ettema, 2004). BH players showed a ∑6 Skinfold of 84.50 ± 20.85 cm. We found no other references to BH players, but with regard to TH players, this value is very low compared to that presented by Vila et al. (2012).

The somatotype of the BH players (Figure 1) is presented using a model characterized by mesomorphy-endomorphy, with lower values than those presented in TH players BH players have a lighter physiognomy than TH players. The ability to grip the ball with force is crucial for the throw (Visnapuu & Jürimäe, 2007), and for this reason we evaluated the handgrip shown by the BH players. The results obtained (Table 2) show very similar values to those shown by elite TH players, being higher than those found in the wings, and lower than the backs (Vila et al., 2012). Throwing velocity is a determining factor for performance in handball (Gutierrez-Davila, Rojas, Ortega, Campos, & Parraga, 2011). The values obtained in this study are higher than those obtained in other studies with TH players in throws from stop and 3-step runs (Granados et al., 2007; Vila et al., 2012). This may be due to the characteristics of the BH ball, where the mass and circumference are smaller than the TH ball (BH 280 to 300 g and 50 to 52 cm in diameter; TH 325 to 375 g and 54 to 56 cm in diameter). However, the 360º Jump Throw Velocity was considerably lower. The mean value obtained was 18.69 ± 4.26 m·s^{-1}, which may be logical because of the great coordinative complexity of its execution.

With regard to lower limb strength, female BH players showed lower values (Table 2) than the TH players in the study by Vila et al. (2012) in CMJ measured on a hard surface. In addition, the sample showed higher values (Table 2) than those shown by the Brazilian BH players in a 10-m sprint (Silva et al., 2016). In terms of Repeated Sprint Ability on Sand, (RSAS), we found no study with similar methodological characteristics to the ones shown in this study. Buchheit et al. (2009) proposed a similar method to this study, but carried out on a hard field with young male and female players, so it is not possible to compare absolute data from both studies. However, we can make reference to the data obtained in terms of the percentage of loss of speed, pointing out that the BH players in the sample showed a lower percentage (Table 2) than that found by Buchheit et al. (2009).

Conclusions

The female Spanish World Champion Beach Handball players showed anthropometric characteristics with lower values than those shown by BH players of other nationalities, and by TH players. They also showed a higher throw speed than TH players, whereas the values for lower limb strength were lower than those obtained by BH players of other nationalities, and by the TH players. These data could be useful for BH coaches in terms of talents identification and for the programming of specific training aimed at achieving high levels of performance in BH.

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